South Puget Sound Dissolved Oxygen Study -- Interim Nutrient Load Summary

Response to Comments

2/17/2011

No.	Section	Page	Comment	Commenter	Response
1	General	General	(Global) Replace of "loads **from**" (Central Puget Sound/South Sound) with "loads **into**". This is more precise and avoids the inference that you have estimated the fraction of the load that is transported into South Sound	King Co.	This change has been made globally
2	Appendix A	General	Define DIN, NO3N, NH4N, TP, OP, CBOD, etc. and give units used for their measure. i.e. mg-N/L	King Co.	All parameters have been defined in Appendix A, under "Abbreviations and Acronyms", and also given the units of measurement in this appendix.
3	Abstract	1	Clarify that field data indicate levels below **numeric** water quality criteria.	King Co.	The following line was modified: *Field data have shown that portions of South Puget Sound fall below Washington State* ***numeric*** *water quality standards for dissolved oxygen*
4	ES	Introduction	See Comment 3. Add sentence decribing that DO levels are naturally low in fall due to Pacific upwelling.	King Co.	We have added a sentence in the Introduction section: *Dissolved oxygen levels decrease when excess nutrients, particularly nitrogen, enter Puget Sound, stimulating algae growth. These algae subsequently die and decompose a process which consumes DO.* ***Coastal upwelling of low DO water may also influence Puget Sound oxygen levels (Landry and Hickey,1989)****. Low DO levels can be harmful to fish and other marine life, raising concerns about the health of the Puget Sound ecosystem.*
5	ES	xvii	Add paragraph describing how natural loads were calculated	King Co.	A paragraph was added, see pg xix of report
6	ES	Figure ES-8	Since you are comparing loads from various sources here, you should include the oceanic load as well.	King Co.	We brielfy mention oceanic loads in the Executive Summary (pg. xi). We have also added a subsection titled "Oceanic Loads" under Combined Loads in the Results section stating that these loads will be developed as part of the modeling effort. This section includes an explanation of how these will be defined.
7	Introduction	page 2	Central PS was added to the study to improve BCs to South Sound. It seems more appropriate to compare Central PS loads to the oceanic load than to the South PS loadings.	King Co.	See comment #6 above. Also, we are still interested in comparing CPS and SPS because loading into CPS may affect SPS water quality. The boundary conditions in the model will include loading from the ocean north of CPS.
8	Introduction	page 3	typo: three-dimensional	King Co.	Corrected

9	Introduction	page 3	Does the GEMSS model also require daily data at the open boundary? Was a multiple-linear regression done for this? Please present the results or discuss how the oceanic load will be defined by the model.	King Co.	The open boundary conditions in the GEMSS model are forced by specified tidally-varying water levels at 6 minute intervals based on predicted tides. The Puget Sound Tide Channel Model (PSTCM) was used to predict water surface elevations of the open boundary at Edmonds based on the amplitude and phase of the full suite of tidal constituents (Lavelle et al., 1985; Mofjeld et al., 2002). Finlayson (2004) developed a stand-alone version of the updated PSTCM called PSTIDES that we used for this project. Concentrations of water quality variables at the open boundary were forced at the open boundary based on linear interpolation between sampling dates for observed data collected at two stations across a transect near Edmonds. The hydrodynamic model in GEMSS computes dynamic flows of water across the open boundary for each time step (10 to 120 seconds) in response to the changing boundary conditions. The prescribed linearly interpolated concentrations of water quality variables at the open boundary are applied to the predicted flows to estimate mass transport at each time step for each water quality constituent.
10	Methods	Table 3	Lake Washington - is Issaquah Creek included in the Equation the Estimate Flow?	King Co.	For Lake Washington, Lincoln's original formulation included Issaquah Creek. However, when we went back and looked at the USGS gaging schematics the flow from Issaquah Creek was already accounted for in one of the other gaging stations (essentially Lincoln was counting the flow from Issaquah Creek twice; an error on his part). Our decision to drop the duplicate Issaquah Creek from the formulation was to remedy this error in Lincoln 1977. We also updated the coefficients so that they reflect our latest watershed area estimates.

11	Methods	Table 3	I think you are overestimating the Green River flow by adding in the Sammamish River. The flow into the Green downstream of Auburn is accounted for by the 1.1 factor and the Sammamish River has a very different hydrologic characteristic than the Lower Green system.	King Co.	For Green R. we basically used the original Lincoln 1977 formulation. However Lincoln used Green-Tukwilla and we used Green-Auburn. The difference in gaged area between these two sites is what gives us the 1.1028 scale factor; basically the Auburn station is a bit farther upstream so we scaled it up (based on area) so that it mimicked the flows at Green-Tukwila. Lincoln also added in the scaled flows from the Sammamish to account for the ungaged area in the Green R watershed. We did the same thing except we used our latest area estimates which is why our scale factor is a bit smaller than Lincoln's (i.e., .3701 vs. .4904). All said, its just a slightly updated version of Lincoln 1977.
12	Natural Conditons	bottom pg 21	The choice of the 10th percentile statistic does not seem reasonable. The objective is to estimate the average annual load. Three paragraphs above you describe "…data indicate seasonal variability. Many of the less developed watersheds have very low concentrations in the summer months" And you found (pg 26) that average annual loads could be biased low by missing winter storms. Selecting the 10th percentile value effectively selects the low summer concentration and applies it as an annual average resulting in a significant under-estimate of the annual load. Suggest you remove this approach to estimating annual loads.	King Co.	After reviewing comments on Natural Conditions, we have modified our approach to calculating natural conditions. The same concept is used, but instead of a single annual concentration value, we developed monthly concentrations based on statistics calculated for monthly data (where monthly data were available). This addresses concerns related to the effect of seasonality on concentrations.
13	Natural Conditons	Table 4	There are additional monitoring locations that are more representative of low development areas. Eg. KC station E319 on the Green River and I would expect SPU and Tacoma have WQ data for their water intakes.	King Co.	The headwaters of the Green River watershed are alpine and forested. However, KC E319 is located below Howard Hanson Dam, which means that data collected here is not necessarily representative of low development and includes the effect of river management.
14	Natural Conditons	page 22	The USGS study by Embrey and Inkpen is another source of info.	King Co.	Table 1 in this study (http://wa.water.usgs.gov/pubs/fs/fs.009-98/table1.html) basically finds that three tributaries to the Hood Canal (Hamma Hamma, Duckabush, Doesewallips) are the only ones without point sources and without animals or agriculture. However, we have this area covered in the Hood Canal DO Program number.
15	Results	page 25	First sentence: reword for clarity - "Regressions for forms of nitrogen except NH4N performed very well."	King Co.	Reworded

16	WTP Loads	page 40	The comparison given here could lead the reader to thinking Central PS TPs are more important to South Sound than is actually the case. Add note that modeling is needed to estimate the fraction of the Central Sound load that enters South Sound.	King Co.	To avoid this misunderstanding, we have added subsections in the ES and the Discussion sections of the report titled "The Impact of Nitrogen Loading". This should clarify that the magnitude of the load does not necessarily correlate with the magnitude of the problem, and that modeling will help us take into account the other environmental variables (e.g. temperature, incoming oceanic water, and the time, location and depth where loading occurs) before evaluating the impact of nutrient loads.
17	Combined Loads	page 47	Top two paragraphs read like river + WWTP = total load, particularly when statistics like "37% of the load" are given. Need to be clear that there are other sources of loads (e.g. oceanic) and that the effect of river and WWTP loads are not necessarily similar due to vertical stratification. Suggest considering if these two paragraphs and Fig 24 are essential, otherwise remove.	King Co.	See comment #16 above.
18	Combined Loads	page 48	How about the oceanic load?	King Co.	See comment #6
19	Natural Conditons	Table 10	median of data will tend to underestimate load - mean would be more appropriate. Even this should be recognized as having the possibility to underestimate given known correlation between nutrients and flow in runoff	King Co.	We have replaced medians with means in our calculations of Natural Conditions.
20	Natural Conditons	page 50	lower N at the Olympics station could also be a result of excess dilution from above average rainfall amounts	King Co.	In this section, we have added a sentence saying that this staion does experience higher rainfall and therefore, concentrations may be biased low. However, it is the only station upwind of local atmospheric nitrogen sources, and therefore more relevant to our calculation of natural conditions.
21	Natural Conditons	Table 11	As you found, this type of calculation can be challenging as a high fraction of the load occurs during storm events were sampling is sparse. Do look at the Green Duwamish Statistical and Pollutant Loading report (http://green.kingcounty.gov/WLR/Waterres/StreamsData/reports/green-duwamish-loading-report.aspx), particularly Table 5-11 where an annual average unit load is calculated for the upper Green by combining base flow and storm flow samples.	King Co.	
22	Discussion	page 52	Clarify/Revise: First sentence summarizes loads "within the study area"; however loads are given for combined South Sound and Central PS. The QAPP defines the study area as south of Tacoma Narrows.	King Co.	This sentence was revised to clarify.

23	Recommendations	page 55	There aren't really any recommendations here. Either reword to make recommendations more clear or rename as "Summary" or combine with Conclusions.	King Co.	The recommendations section was edited and some paragraphs were moved to the Conclusions.
24	Recommendations	page 55	Clarify first paragraph is referring to river and WWTP loads only.	King Co.	Sentence was changed to clarify.
25	Appendix E	Figure E-9	Take a look at the regression for NO23N for Tacoma Central - it looks like one high value is driving a sinusoidal component that doesn't show in the rest of the data.	King Co.	Tacoma-Central data were most variable compared to other WWTPs. Removing this value does remove the sinusoidal component. However, this results in a very small change in DIN load from 2056 kg/d to 2042 kg/d, so the effect is small (0.007%, since most of the DIN load is in the form of NH4N).
26	Appendix E	Figure E-13	There is a data point for NO23N that is cut off the figure - just above 10 mg/L	King Co.	Good eye! We fixed the plot.
27	Appendix F, G		Add text to clarify how these loads were calculated. Are they based on monthly samples or on the regression fits to the data?	King Co.	Text was added to both Appendix F and G to clarify that these are based on the regression. The title for both was also changed from "Nutrient Data" to "Nutrient Estimates".
28	ES	Figure ES-1	Add Central Puget Sound boundaries that's referred to in the text, not just the study and model areas	King Co.	The Central Puget Sound boundary is coincident with the "Model Boundary Area" i.e. they are one and the same. The legend was modified to also have "South PS" and "Central PS" to clarify this.
29	Introduction	Table 1	add water volume for each (in cubic km) region rather than just area	King Co.	We added volumes to this Table.
30	Watershed Loads	page 28	King County had flow and nutrient data for Judd Creek (some Shingle Mill Creek and other creeks) on Vashon Island	King Co.	We had our own data for these creeks and decided, for consistency, to use our data instead of adding additional sources.
31	Acknowledgements	Page vii	First bullet, first sub-bullet: please replace Nate Barto with Doug Kohl and Joyce Chavez with Joseph Gibbens or add Doug and I.	Joint Base Lewis McChord	Change made
32	Methods	Page 5	Page 5, Watershed Loads, Field Data Collection, first paragraph, first sentence: Sentence states that monitoring was conducted at 38 rivers and streams, subsequent Table 7 only lists 37.	Joint Base Lewis McChord	There are two Deer Creeks in the study area, one tributary to Oakland Bay and another to Little Skookum. For Deer Creek/Oakland Bay, we monitored the creek for 3 months but did not develop regressions based on the shorter period of monitoring. That was an oversight on our part. When we developed regressions for each watershed, we combined Cranberry and Deer Creek/Oakland Bay. We did not monitor Deer Creek/Little Skookum. Instead, we used an adjacent watershed to estimate loads. We monitored a total of 38 rivers to describe the 37 watersheds that appear in Table 7. We omitted Deer Creek/Oakland Bay from Table 7.

33	Methods	Page 5	Page 5, footer 1: Footer states that originally there were 39 locations including Sequalitchew Creek which was found to be diverted and no outlet found. The outlet for flows from Sequalitchew Lake (headwater of Sequalitchew Creek) and some stormwater from Joint Base Lewis McChord is located just north of the Solo Point WWTP. I have submitted requests to several consulting companies who have done work on that diversion channel to determine if any nitrogren data are available. Flows in the diversion channel can exceed 15 cfs in the winter so this is a pretty substantial flow. If these data are of value I will send them along.	Joint Base Lewis McChord	Even though we did not monitor Sequalitchew Creek, we did estimate loads from this creek using the same methodology as we did for the other unmonitored creeks, so it's flow and load is accounted for in our estimates. Thank you for sending us the data for this creek - though this data is useful, it does not cover the time period of our study (2006-2007), and is insufficient to develop daily daily nitrogen estimates based on the statistical method we used (there are only three 3 data values made in 1999 and 2002). However, the data do show that our estimates are within the right ballpark. Given that flow from sequalitchew makes up less than 1% of the total flow from all rivers and streams in the study area, the model will not be sensitive to our estimate of nitrogen loading from this one creek.
34	Methods	Page 5	Page 5, foot 1: Despite being dropped from the original 39 sampling locations Sequalitchew Creek is included in Figure 5 as a source; Figure 8 for DIN concentrations; Fig 10 for DIN loading and also Figures F8 and F9….my reading of the footer is that no data from Sequalitchew Creek was obtained….but data are presented later in the report.	Joint Base Lewis McChord	You are right that we did not monitor Sequalitchew Creek, but we estimated nutrient loads for this creek like we did for a number of other streams that were not monitored. Therefore, the Sequalitchew is not included in Figure 3 (which shows only monitored locations), but is included in subsequent figures because we developed nutrient loading estimates even for creeks that were not monitored. The method used to develop these estimates for unmonitored streams is described in in the "Methods" section of the report. Figures 8, 9, etc show the estimated nutrients for all streams, not just monitored locations.
35	General	General	The loading report is all about DIN (or mostly). Why not look at TN as well since it will decay into DIN? I'm just analogizing to river nutrient studies, where we focus on TP (but also keep track of OP). The South Sound model is going to have organic N as an input, right? I don't mean to double the size of the report (!), but wonder if a little more should be said about TN.	EPA	The appendices have plots of all constituents. We focused on DIN as the most usable component, but yes eventually organic nitrogen can become a food source. In reality, there is very little organic nitrogen from either WWTPs or rivers, and DIN is nearly all of the TN present. To keep the main body of the report as concise as possible, we focused on DIN. We did the calculation, and on average, 86% of TN loads from rivers and 90% of TN loads from WWTPs are in the form of DIN. We have added these numbers in a blurb in the report in the "Results" section to show that very little of the TN is of organic form, and have also added that the model will account for all the different forms of nitrogen.

36	Natural Conditions	Page 52	Ben Cope suggested removing the following methods in our calculation of the overall natural condition: air deposition (since this is not river data), historic data (since these values are higher than recent data), use only baseflow, not stormwater from the forested basins estimate. Also, don't use median of median, but take the mean of the means of the different methods. Mention in the text that flow variability is bigger than concentration variability with an example.	EPA	After reviewing comments on Natural Conditions, we have modified our approach to calculating natural conditions. The same methods are used, but instead of a single annual concentration value, we developed monthly concentrations based on statistics calculated for monthly data (where monthly data were available). This addresses concerns related to the effect of seasonality on concentrations. We also switched to using the mean of the means rather than the median of the medians. We are, however, still using the same methods in our calculation. We kept air deposition data because it the only data we have that does not include anthropogenic sources of nutrients. We kept historic data because it is the oldest water quality data we have, even if concentrations are higher than might be expected. We kept stormwater plus baseflow in forested basins because both are natural and using only baseflow would bias concentrations to the low side.
37	ES	General	Before the sentence about testing the sensitivity of loadings in Central Puget Sound add a sentence something like, "It is generally considered that a kg of N will have a greater affect the further inland the kg is discharged because of decreasing circulation going from Admiralty Inlet to Central Main Basin to South Puget Sound." This concept is based on the general concept of assimmulative capacity, dilution and the reflux model (Cokelet et al, 199x) in particular.	USGS	The effect of nitrogen loading will vary due to a variety of factors, not just distance from the shoreline or from the boundary. For example, the depth where loading occurs is also important. If the loading is below the depth of no motion but it is closer to Edmonds it could have more influence than the same amount of loading at the surface that is closer to The narrows. We have added a short subsection in the Executive Summary and Discussion sections of the report titled "The Impact of Nitrogen Loads" to clarify that the magnitude of the load does not necessarily correlate with the magnitude of the problem, and that modeling will help us take into account the other environmental variables (e.g. time, location and depth where loading occurs) before evaluating the impact of nutrient loads.

38	Appendix C		Our main concern is related to the 10% estimate used for buildings within a 150 meters of the shoreline. Our request is that more information be included in the Technical Memorandum related to the 10% estimate for DIN loss. The results from studies completed since 1973 (the studies that USGS used to come up with the 10% estimate), using 10% for all OSS within 150 meters of the shoreline would be overly conservative. By using the 10% estimate without further clarification for why the most conservative factor was used would leave people with the idea that 10% is a reasonable estimate. We suggest noting in the following paragraph that the 10% estimate used by USGS was based on studies from 1973 and by using the 10% DIN loss, the results demonstrate an extremely conservative estimate. "The USGS applied a de-nitrification loss rate of 10% to its assessment of DIN loading associated with shoreline-based on-site systems in Hood Canal (Paulson, 2006). Analyses of nitrate attenuation conducted further afield of on-site drain fields reported levels as high as 90% (Horowitz, 2008)." We understand that the Technical Memorandum includes information and other methods for finding the on-site loading and that the 10% estimate doesn't impact the results. However, without further explanation to the variability and conservative estimate, future reports may reference this one erroneously.	DOH	We agree that nitrogen attenuation in soils after release from septic systems is variable and not well understood. We concur that additional information on attenuation would be helpful and we included it in the recommendations section.